ATTORNEY DOCKET NO. KANEDA 1-2-2 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Noriaki Kaneda, *et al.*
Serial No.:	10/627,098
Filed:	July 25, 2003
Title:	METHOD AND APPARATUS FOR ELECTRONIC EQUALIZATION IN OPTICAL COMMUNICATION SYSTEMS
Grp./A.U.:	2613
Examiner:	Shi K. Li

Confirmation No.: 3673

Commissioner for Patents
Washington, D.C. 20231

I hereby certify that this correspondence is being electronically filed with United States Patent and trademark Office on:

___May 7, 2008__________________(Date)

__Karen Vertz_____________________________
(Printed or typed name of person signing the certificate)

___/Karen Vertz/____________________________________
(Signature of the person signing the certificate)

Sir:

DECLARATION UNDER 37 C.F.R. § 1.132

1) I, Ut-Va Koc, received a Ph.D. in 1996 from the University of Maryland, College Park, MD. My Ph.D. research involved the application of digital signal processing techniques to digital video coding. I have been doing research on digital signal processing for communication for about 12 years as a Member of the Technical Staff and more recently as a Distinguished Member of the Technical Staff at Bell Laboratories, Alcatel-Lucent (Formerly Lucent Technologies, Inc.), Murray Hill, New Jersey. I am an inventor or co-inventor on two issued U.S. patents, and am a named inventor or co-inventor on at least eight pending patent applications.

2) I am a co-inventor in the above-referenced U.S. Patent Application.

3) I am an author or co-author on, at least, 30 publications in scientific journals and one book on the subject of high-speed communications.

4) In preparing to make this Declaration, I have reviewed relevant portions of:

A) U.S. Patent No. 7,130,366 B2 to Phanse, *et al.* (herein referred to as "Phanse");

B) U.S. Patent No. 6,718,087 B2 to Choa, *et al.* (herein referred to as "Choa");

C) Walach, *et al.*, "The Least Mean Fourth (LMF) Adaptive Algorithm and its Family," IEEE Transactions on Information Theory, Vol. IT-30, No. 2, pages 275-83 (March 1984) (herein referred to as "Wallach"); and

D) A. Zerguine, "Convergence Behavior of the Normalized Least Mean Fourth Algorithm," Conference Record of the Thirty-Fourth Asilomar Conference on Signals, Systems, and Computers, 2000, 29 Oct.-1 Nov. 2000, Vol. 1, pages 275-78 (herein referred to as "Zerguine").

5. Persons of skill in the art usually assume that electronic noise in an optical system is Gaussian in nature. This assumption is made in part because computation of the bit error rate (BER) and the Q-factor of the system are simplified by the assumption of Gaussian noise. Specifically, a Gaussian distribution may be compactly characterized by its mean and variance. A non-Gaussian distribution is more complex. Thus, a mathematical model generally requires additional terms to represent the non-Gaussian nature of such a distribution.

In the present application, an optical signal is converted to an electrical signal by a photodiode. A photodiode produces an electrical signal that includes a component linearly proportional to the noise present on the optical signal, and a component proportional to the *square* of that noise. An assumption that the noise of such an electrical signal is Gaussian implies that the squared term is assumed to be negligible. This implication is justified because the noise in a combination of the

linear and square components would not generally be Gaussian if both terms have comparable magnitudes even if the noise in the original optical signal was Gaussian in nature. In most cases, the assumption of Gaussian noise is justified or taken for granted, because the magnitude of the squared term is much smaller than the linear term. In my opinion, unless square-optical-noise contributions to the electrical signal are large enough they may not be neglected, one of ordinary skill would not operate contrary to this assumption because of the advantages in computing Q and BER that result from this assumption.

6a. Based on my scientific experience and training, I conclude that Choa discloses transmission through a short optical fiber transmission line for which the contribution of additive optical noise to an optical signal would very likely be very small. In particular, optical amplifiers typically produce additive optical noise due to spontaneous emission therein. For that reason, additive optical noise often provides a non-negligible contribution to an optical signal that has propagated through a long series of optical amplifiers. That is, the additive optical noise grows relative to the optical signal as the optical signal passes through more optical amplifiers. In a short optical fiber transmission line, additive optical noise typically does not provide a non-negligible contribution to an optical signal, because the optical signal does not pass through enough optical amplifiers for additive noise to attain a substantial magnitude relative to that of the transmitted optical signal.

6b) Choa discloses transmission through a multi-mode fiber (MMF). MMF allows multiple optical modes to propagate. The different optical modes in a MMF would typically have different propagation speeds. For that reason, MMF is not typically suitable for long optical communication fiber transmission lines, *e.g.*, 1000 km or more. Thus, based on my scientific

training and experience, I would not expect the optical transmission system of Choa to be the basis of an optical fiber transmission line with a long series of optical amplifiers. For that reason, I would conclude that the system of Choa would very likely not produce substantial additive optical noise in a transmitted optical signal.

Indeed, I note that Choa makes disclosures that indicate that his optical fiber transmission line is probably very short. In particular, at column 1, lines 24-28, Choa notes a MMF is typically limited to a bandwidth-distance product of about 300 MHz-km or less, corresponding to a span length of about 30 meters at a data rate of 10 Gb/s. Indeed, Choa also discusses strategies that may extend this length to 1 kilometer. Thus, Choa's own disclosures strongly indicate that his optical fiber transmission systems are limited to a distance on the order of 1 kilometer. Such short transmission systems would very likely not contribute a significant additive optical noise to a transmitted optical signal, because such systems would not need a series of optical amplifiers.

A photodiode converts a received optical signal into an electrical signal with substantially Gaussian noise if the optical signal has been transmitted through an optical fiber line that does not generate significant additive optical noise. That is, based on my scientific experience and training, additive optical noise is the reason that a converted electrical signal typically has a non-Gaussian electrical noise. This aspect is illustrated in Equation 1 of the application under consideration. Since the optical fiber line of Choa does not produce significant additive optical noise in transmitted optical signals, I conclude that Choa's photodiode would produce an electrical signal with Gaussian noise therein.

7. Based on my scientific experience and training, I conclude that Wallach and Zerguine do not demonstrate reduced time or lower error in the computation of coefficients of an adaptive electronic equalizer for the case of an electrical signal including a noise distribution substantially

described by the sum of a component linearly proportional to a model distribution and a component proportional to the square of the model distribution. (For example, a model distribution may be a Gaussian distribution.) Zerguine models the behavior of the normalized least mean fourth (NLMF) algorithm only for the case of additive noise that is zero-mean with a uniform distribution. This corresponds to the case shown in Figure 3(b) of Wallach. This noise distribution is not analogous to the distribution of noise that one would expect at the output of a photodiode of a long-haul optical transmission system. In such a system, the output of the photodiode would be expected to be substantially described by a component linearly proportional to the noise (Gaussian, e.g.) on the incoming optical signal and a component proportional to the square of that noise. Because the incoming noise is expected to be centered about zero, the negative portion of that noise when squared contributes to the noise distributed above zero in the output of the photodiode. This distribution is qualitatively different from the noise for which Zerguine models the NLMF algorithm. Due to this fundamental difference in noise distributions, in my opinion, the results of Zerguine would not have convinced a person of skill in the art to use the NLMF algorithm in an optical receiver for a long-haul optical system, *e.g.*, having a length greater than about 1000 km.

7. Based on my scientific experience and training, I conclude that Zerguine assumes an unknown system is a non-minimum phase channel given by $\mathbf{c}_{opt}=[0.5,\ 1]^T$, implying that the previous data s(n-1) plus half of the current data s(n) affects the current channel output data $x=c_{opt} * s$ (this is a non-minimum phase channel). This creates ISI (intersymbol interference) and will linearly affect the post-channel noise. However, this effect is *linear* unlike a square-law photodetector, which has a *nonlinear* (squared term, *e.g.*) effect on the noise and the ISI. Due to this fundamental difference, I conclude that the results of Zerguine would not have convinced a

person of skill in the art to use the NLMF algorithm in an optical receiver for a long-haul optical system.

9) I, Ut-Va Koc, herein certify that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I also understand that willful false statements and the like are punishable by fine, imprisonment or both under 18 U.S.C. § 1001 and that willful false statements and the like may jeopardize the validity of the application-at-issue or any patent issuing thereon.

Executed this 7th day of May, 2008, at New Jersey.

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